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Short communication: Intensive measurements of standing time of dairy calves housed in individual pens within a naturally ventilated, unheated nursery over different periods of the year

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ABSTRACT

Holstein calves, 2 to 5 d of age initially (42.8 ± 2.1 kg of body weight) from a single dairy farm, were transported 3.5 h to southwest Ohio. Calves were housed in 1.2 × 2.4 m individual pens with wire mesh sides within a curtain sidewall barn with no added heat. Pens were bedded with long straw and fed 0.68 kg (as-fed) of milk replacer powder reconstituted to a 14% dry matter daily in 2 equal meals at 0615 and 1600 h. Starter and water were offered ad libitum. Calves were weaned at 42 d with measurements made until d 56. Ten calves per period in 4 periods of the year (spring/summer, SS; summer, S; fall, F; winter, W) were used to measure standing and lying behavior using an electronic data logger attached to the medial side of the right rear leg of calves. In period SS, loggers were attached from d 2 to 6, 10 to 17, 25 to 32, and 33 to 56. In periods S, F, and W, the logger was attached from d 4 to 56. Standing time was estimated from 5-min interval recordings. Data from the first 2 d after attachment were not used. Standing time did not differ among periods and averaged 303 ± 52.8 min/d. These measurements were low, and approximately 2 h/d less than other measurements found in the literature. Standing time differed among sections of the day and was greatest during a.m. and p.m. feeding, intermediate during midday and evening, and least at night. No interaction of period of year by time of day was noted. Standing time increased by 0.52 ± 0.063 min/d with increasing age of calf (approximately 26 min per 7 wk). Variances of standing time within period of year due to calf and variances across periods were compared and did not differ. In summary, calves averaged approximately 300 min/d standing, and time standing increased by approximately 0.5 min/d with age and did not differ with period of year.
Key words: standing time, behavior, season, calf

Short Communication

Calf housing, welfare, and behavior have been studied in regard to housing, bedding, and feeding systems and are important for optimal performance, health, and humane treatment of the calf (McFarlane et al., 1988; Chua et al., 2002; Jensen, 2004; Panivivat et al., 2004; von Keyserlingk et al., 2006). These studies have used different techniques to quantify time spent feeding, standing, lying, and performing natural and unnatural behaviors. Most techniques involved visual monitoring of calves with or without video surveillance. Automated devices and methodologies exist to quantify standing and lying times of cattle (Ito et al., 2009; Ledgerwood et al., 2010) but have not been implemented in calf research or used over long periods (weeks or months). We are unaware of mechanical or structural differences in body confirmation to indicate that methodologies that have proven useful in mature cattle are unacceptable in neonatal calves. Standing requires substantially more energy than lying (Schrama et al., 1993; Labussière et al., 2008). Ambient temperatures above or below the thermoneutral range of calves increases energy required for maintenance or heat production (NRC, 2001), whereas loss of body heat increases during standing, compared with lying, in calves (Schrama et al., 1993).

This study was designed to use a data logger to measure standing time of calves over long periods and during different periods of the year. The objective was to estimate how standing time changed within day and with increasing age. Additionally, an objective was to determine if standing time varied by period of the year.

Holstein bull calves (2 to 5 d of age) from a single dairy farm were transported 3.5 h to the Nurture Research Center in southwest Ohio and received at approximately 1100 h. Calves were housed in 1.2 × 2.4 m individual pens with wire mesh sides within a curtain sidewall barn with no added heat; the pens were bedded with straw. A 27% CP (whey protein), 17% fat milk replacer (**MR**) powder (DM basis; Table 1) was reconstituted with warm water to 14% solids. Calves were fed 0.68 kg of as-fed powder via this solu-

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Table 1. Start dates, end dates, and ambient nursery temperatures (mean and range) of the 4 periods of calf measurements

Period	Start date	End date	Temperature, °C
Spring/summer (SS)	June 4	July 27	24 (13 to 36)
Summer (S)	August 10	October 5	22 (11 to 38)
Fall (F)	October 19	December 14	7 (−18 to 22)
Winter (W)	December 28	February 22	1 (−15 to 15)

tion daily in 2 equal meals at 0615 and 1600 h. Calves were completely weaned by d 42 by only feeding MR at 0615 h on d 40, 41, and 42. Calves were fed a textured starter (20% CP on DM basis); starter and water were offered ad libitum. Calves were cared for by acceptable practices as described in the *Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching* (FASS, 2010).

Ten calves (42.8 ± 2.1 kg of initial BW) per period in 4 periods of the year (spring/summer, **SS**; summer, **S**; fall, **F**; winter, **W**; Table 1) were used to measure standing and lying behavior using an electronic data logger (Hobo Pendant G Acceleration Data Logger, Onset Computer Corp., Pocasset, MA) attached to the medial side of the right rear leg of calves. A plastic identification bracelet (Nasco, Fort Atkinson, WI) was attached to the leg and the logger was taped (Vet Wrap Co-Flex, Andover Coated Products Inc., Salisbury, MA) to the bracelet. Tape was then applied over the logger and bracelet. In period SS, the loggers were attached from d 2 to 6, 10 to 17, 25 to 32, and 33 to 56, and set to record every 1 min. Data from the first 2 d of each recording period were not used to allow the calf to acclimate to the logger. In periods S, F, and W, the logger was attached on d 4 and set to record data every 5 min from d 6 to 56. Data were managed in 1-min intervals or with adjustments for a 5-min recording interval and categorized either as standing or lying similar to the description (Ito et al., 2009).

The data recorders have the ability to store approximately 7 d of data when recording each minute. Because we wanted to record for longer periods of time we evaluated recording at 5-min intervals instead of every minute. For period SS, standing time was recorded by calf in 1-min intervals and these data were separated into 5 sets by 5-min intervals to be calculated. Standing time by 1-min intervals was compared with the 5 sets of 5-min intervals within each calf. Correlations within individual calves ranged from 0.97 to 0.99 with an average of 0.98. Estimated standing time was 9 min/d (3%) greater when using 1-min intervals rather than 5-min intervals. Ledgerwood et al. (2010) demonstrated that intervals from 0.1 to 5 min were valid for estimating lying time with this brand of data logger. Additionally, we deleted the first 2 d of data after attachment of the logger in case attachment created initial abnormal behavior, another reason we wanted to leave the recorders attached throughout the trial.

Hours of the day were grouped into 5 arbitrary periods of the day: feeding MR in the morning (3 h from 0500 to 0800 h), midday (7 h from 0800 to 1500 h), feeding MR during the afternoon (3 h from 1500 to 1800 h), evening (4 h from 1800 to 2200 h), and night (6 h from 2200 to 0400 h). We determined these periods based on: human interaction of feeding MR; midday periods when calves were watered, fed starter, bedded, measured for growth, and cared for in other ways; evening periods after caretakers left the nursery yet daylight was present during warmer months; and night.

Data were analyzed using the MIXED procedure in SAS (Version 8, SAS Institute Inc., Cary, NC) as a completely randomized design with a 4 (periods of year) × 5 (sections of day) factorial arrangement. The repeated measures mixed model was the following:

$$Y_{ijkl} = \mu + P_i + S_j + PS_{ij} + A_k + PA_{ik} + SA_{jk} + PSA_{ijk} + \varepsilon_{ijkl},$$

where Y_{ijkl} is observed response; μ is the mean; P_i is fixed effect of period of year i; S_j is fixed effect of section of day j; PS_{ij} is the interaction of period i and section of day j; A_k is the repeated effect of age (interval measured) k that was modeled as an auto-regressive type 1 covariance matrix within experimental unit; PA_{ik}, SA_{jk}, and PSA_{ijk} are the interactions of period of year i, section of day j, and age k; and ε_{ijkl} is residual error, calculated using the Kenward-Rogers procedure for determining degrees of freedom. Means were separated using an least significant difference (LSD) means separation procedure. All data are reported as LSM. The experimental unit was calf. Significant differences were considered at $P < 0.05$.

Standing time did not differ among periods of year (SS, S, F, and W) and averaged 303 ± 52.8 min/d. Standing time did differ among sections of the day, being greatest during a.m. and p.m. feeding, intermediate during midday and evening, and least at night ($P < 0.001$; Figure 1). No interactions of period of year with section of day ($P > 0.2$) were noted. Standing time